
Supplementary information

**A network analysis of COVID-19 mRNA
vaccine patents**

In the format provided by the
authors and unedited

Supplemental Information:

Methodology:

The vaccine technology was evaluated for each company and then databases were searched for patents/applications that mapped onto the vaccines. mRNA vaccines require encapsulation of the mRNA within a lipid nanoparticle in order to be able to deliver the mRNA inside the cell, so patents focused on lipid nanoparticles and uses for the delivery of therapeutics were searched. The search also included methods and uses for mRNA/RNA therapeutics, lipid nanoparticles and delivery systems, cellular RNA expression. This is not an exhaustive list and does not represent legal analysis.

Data:

Table 1. BioNTech Patent Landscape.

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 10,576,146	BioNTech	March 15, 2018	Active	Lipids/NP + mRNA
US 10,485,884	BioNTech	March 5, 2013	Active	Lipids/NP + mRNA
US 9,950,065	BioNTech	September 26, 2013	Active	Lipids/NP + mRNA
US2020/0155671	BioNTech	January 22, 2020	Pending	Lipids/NP + mRNA
US2020/0197508	BioNTech	March 21, 2018	Pending	RNA immune response
US2019/0153428	BioNTech	August 24, 2016	Pending	RNA immunogenicity
US2019/0321458	BioNTech	July 14, 2017	Pending	PC: Lipids/NP + mRNA
US2018/0263907	BioNTech	March 30, 2016	Pending	Lipids/NP + mRNA
US2017/0273907	BioNTech	September 17, 2015	Pending	Lipids/NP + mRNA
US2014/0030808	BioNTech	December 2, 2011	Pending	RNA expression
WO2016/156398	BioNTech	March 30, 2016	Published	Lipids/NP + mRNA
WO2015/043613	BioNTech	September 26, 2013	Published	Lipids/NP + mRNA
WO2013/087083	BioNTech	December 15, 2011	Published	Lipids/NP + mRNA

Table 2. Moderna Patent Landscape.

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 10,703,789	Moderna	June 12, 2019	Active	PC: Lipids/NP + mRNA
US 10,702,600	Moderna	February 28, 2020	Active	Betacoronavirus mRNA Vaccine
US 10,577,403	Moderna	June 12, 2019	Active	PC: Lipids/NP + mRNA
US 10,442,756	Moderna	December 18, 2017	Active	Lipids/NP + mRNA
US 10,266,485	Moderna	June 11, 2018	Active	Lipids/NP + mRNA
US 10,064,959	Moderna	April 21, 2017	Active	mRNA synthesis
US 9,868,692	Moderna	March 31, 2017	Active	Lipids/NP + mRNA
US2020/0206362	Moderna	October 11, 2019	Pending	PC: Lipids/NP + mRNA
US2020/0164038	Moderna	July 29, 2019	Pending	PC: Lipids/NP + mRNA
US2019/0015501	Moderna	September 27, 2018	Pending	Nucleic acid vaccine
WO2016/118724	Moderna	January 21, 2016	Published	Lipids/NP + mRNA
WO2016/118725	Moderna	January 21, 2016	Published	Lipids/NP + mRNA
WO2015/164674	Moderna	April 23, 2015	Published	Nucleic acid vaccine

Table 3. CureVac Patent Landscape.

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 10,799,602	CureVac	April 1, 2019	Active	RNA expression
US 10,780,054	CureVac	April 15, 2016	Active	Lyophilization of RNA
US 9,669,089	CureVac	February 15, 2013	Active	Nucleic acid molecule
US2020/0179526	CureVac	June 19, 2017	Pending	Nucleic acid carrier
US2020/0085852	CureVac	August 15, 2016	Pending	Epidermal mRNA vaccine
US2020/0345831	CureVac	July 24, 2020	Pending	mRNA composition encoding coronavirus spike protein
US2020/0246451	CureVac	April 2, 2020	Pending	Production of RNA compositions
US2019/0351048	CureVac	June 19, 2019	Pending	MERS coronavirus vaccine
US2019/0314496	CureVac	June 18, 2019	Pending	Nucleic acid carrier
US2019/0083602	CureVac	December 22, 2016	Pending	RNA production
US2019/0336608	CureVac	June 9, 2017	Pending	Nucleic acid carrier
US2018/0296663	CureVac	June 17, 2016	Pending	Nucleic acid vaccine composition
WO2020/002598	CureVac and Tesla	June 28, 2019	Published	Bioreactor for RNA production

Table 4. Arbutus BioPharma Patent Landscape.

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 9,814,777	Arbutus	October 22, 2013	Active	Lipids/particles
US 9,694,077	Arbutus	October 7, 2014	Active	Lipids/particles
US 9,518,272	Arbutus	May 12, 2016	Active	Lipid nanoparticle + mRNA
US 9,404,127	Arbutus	March 9, 2015	Active	Lipid nanoparticle + mRNA
US 9,364,435	Arbutus	August 18, 2014	Active	Lipid nanoparticle + mRNA
US 9,139,554	Arbutus and UBC	October 9, 2009	Active	Lipids/particles
US 8,058,069	Arbutus	April 15, 2009	Active	Lipid nanoparticle + mRNA
WO2020/097540	Arbutus	November 8, 2019	Published	Lipid nanoparticle + mRNA
WO2020/097548	Arbutus	November 8, 2019	Published	Lipid nanoparticle + mRNA

Table 5. Acuitas Patent Landscape.

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 10,221,127	Acuitas	June 29, 2016	Active	Lipid nanoparticle + mRNA
US 10,166,298	Acuitas	October 28, 2016	Active	Lipid nanoparticle + mRNA
US 10,106,490	Acuitas	June 15, 2017	Active	Lipid nanoparticle + mRNA
US2020/0163878	Acuitas and CureVac	October 26, 2017	Pending	Lipid nanoparticle + mRNA
US2020/0046838	Acuitas	April 13, 2018	Pending	Lipids/particles
US2020/0283372	Acuitas	January 10, 2020	Pending	Lipids/particles
US2020/0172472	Acuitas	August 17, 2018	Pending	Lipids/particles
US2019/0022247	Acuitas	December 30, 2016	Pending	Lipids/particles
US2019/0274968	Acuitas and UPenn	October 17, 2017	Pending	Lipid nanoparticle + mRNA
US2018/0185516	Acuitas and Sangamo	December 8, 2017	Pending	Lipid nanoparticle + mRNA
US2018/0303925	Acuitas and UPenn	April 27, 2016	Pending	Lipid nanoparticle + mRNA

Table 6. UBC Patent Landscape.

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 10,653,780	UBC and Arbutus	August 28, 2015	Active	Lipids/particles
US 10,159,652	UBC	October 16, 2014	Active	Device for formulating particles
US 10,041,091	UBC	August 25, 2017	Active	Lipid nanoparticle + mRNA
US 9,758,795	UBC	May 4, 2012	Active	Lipid nanoparticle + mRNA
US 9,943,846	UBC	March 31, 2016	Active	Lipid nanoparticle methods
US 9,139,554	UBC and Arbutus	October 9, 2009	Active	Lipid nanoparticle + mRNA
US2019/0032087	UBC	July 31, 2018	Pending	Lipid nanoparticle + mRNA
WO2013/059922	UBC	October 25, 2012	Published	Lipid nanoparticle methods
WO2011/036557	UBC	September 22, 2010	Published	Lipids/particles
WO2009/086558	UBC, Arbutus, Alnylam	December 31, 2008	Published	Lipids/particles

Table 7. UPenn Patent Landscape. ¹

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 10,232,055	UPenn	October 31, 2016	Active	RNA immunogenicity
US 10,006,007	UPenn	May 20, 2016	Active	RNA methods
US 9,750,824	UPenn	August 11, 2014	Active	RNA immunogenicity
US 9,371,511	UPenn	July 16, 2015	Active	RNA methods
US 9,163,213	UPenn	March 11, 2015	Active	RNA methods
US 9,012,219	UPenn	December 7, 2010	Active	RNA methods
US 8,835,108	UPenn	March 15, 2013	Active	RNA methods
US 8,748,089	UPenn	March 15, 2013	Active	RNA methods
US 8,691,966	UPenn	August 14, 2012	Active	RNA methods
US 8,278,036	UPenn	August 21, 2006	Active	RNA methods

¹ These patents were identified by Knowledge Ecology International.

Table 8. Arcturus Patent Landscape.

Patent/Published Application	Applicant/Assignee	Filing Date	Status	Invention Type
US 10,815,463	Arcturus	November 7, 2017	Active	mUNA methods
US 10,233,148	Arcturus	October 31, 2017	Active	Lipids/particles
US 10,227,302	Arcturus	February 9, 2018	Active	Lipids/particles
US 9,580,711	Arcturus	May 4, 2016	Active	Lipids/particles
US 9,567,296	Arcturus	May 8, 2015	Active	Lipids/particles
US2020/297634	Arcturus	March 18, 2020	Pending	Methods for Lipid nanoparticle + mRNA
US2020/0109113	Arcturus	December 10, 2019	Pending	Lipids/particles
US2020/0046830	Arcturus and USG represented by Secretary of Army	March 30, 2018	Pending	Nucleic Acid Vaccine Composition
WO2019/0388562	Arcturus	July 31, 2019	Pending	Lipids/particles
WO2019/0002906	Arcturus	May 31, 2018	Pending	mRNA methods